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ABSTRACT

This report traces the development of science education, particularly the elementary science curriculum, in Trinidad and Tobago. Problem areas are identified that have influenced science instruction and/or the lack of it. A model is presented for teacher involvement in elementary science curriculum development. Through this approach, approximately 700 teachers were involved with curriculum writing from 1977-1983. The teachers also helped in the implementation of Science - A Process Approach for Trinidad and Tobago (SAPATT). An evaluative study of the SAPATT curriculum is presented and includes: (1) the research plan; (2) statement of problems; (3) methodology (attitude, implementation, evaluation); and (4) present phase of study (procedures, results). The study reveals that high scores have been achieved by SAPATT students and that teachers evidenced significant interest and participation levels in the program. It is recommended that all schools, private and public, should use the program and that SAPATT teacher's guides be distributed to all schools. (ML)

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DEVELOPMENT, IMPLEMENTATION AND EVALUATION OF THE SCIENCE - A PROCESS APPROACH FOR TRINIDAD AND TOBAGO SCIENCE CURRICULUM

(Phase I)

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BACKGROUND OF THE PROBLEM

Science as a part of basic education is a recent development in the education system in the nation of Trinidad and Tobago. It's status has been changed from being an "exclusive" subject for selected students, to that of "compulsory" subject for all students.

The new role ascribed to science is directly linked to the perceived manpower needs of the country, as the following observations made by the Prime Minister in his 1975 proposals to the Cabinet on education so clear outline:-

> Whereas in the past, the opportunities that were available were not very clearly defined, and a general sort of education in the traditional sense was as good as any other, circumstances in Trinidad and Tobago have changed and a clearer picture is emerging. Various studies have shown that for any country involved in heavy industrial development, the requirements for personnel can be broken down generally into the following categories:-
>
> 10 - 15% --- professionals;
>
> 15 - 20% --- sub-professionals and technicians;
>
> 60 - 79% --- persons with general training but with definite exposure to the science and industrial processes;
>
> 10 - 15% --- skilled craftsmen (Williams, 1975, p. 7)

These observations formed the basis for man power projections for the society that was being moved toward industrialization and led to science becoming a compulsory subject for all students at elementary and lower secondary level.

The position of science at the elementary level became established in 1956, when the elementary school syllabus contained a section of Nature Study. The syllabus was rather content oriented and required a great deal of rote

memorization on the part of the student. This syllabus was replaced by a General Science Syllabus in 1975. This syllabus was also content oriented with great emphasis being put on rote memorization. It should be noted that students were being taught by teachers who had a poor science background and who had entered the system either via the pupil-teacher system which was abolished in 1963 or by trained and untrained secondary school graduates.

The majority of teachers have not completed any formal science.

The aims and objectives of the last Teachers' College syllabus were to produce teachers who:-

(a) have a knowledge of the great variety of plants and animals in Trinidad and Tobago;

(b) can stimulate children into asking and answering questions about the world in which they live;

(c) can promote an experimental enquiry approach into their teaching. (Syllabus of Study for Teachers College, 1970, p. 4).

Remarkably absent is the production of teachers who can teach science, and who can train students to think like scientists. No mention is made of science teaching methods. A syllabus with a reasonable balance of content and methodology would have been far more effective in producing science teachers. By 1981, all primary teachers had attended the Teachers Training College; however, they have left with an inadequate exposure to science and a negative attitude toward teaching science (Fraser-Abder and Shrigley, 1980); consequently very few teachers have attempted to teach elementary science.

Another factor which has militated against the teaching of elementary science is the Common Entrance Examination. Up to 1981 Science had not been

a part of this examination. Many principals have been known to remark that their school is judged not by whether or not they teach science but by their Common Entrance Examination results. The teachers' main objective becomes preparing students to pass this examination; consequently they concentrate on this objective and do not teach science. Gocking and Edghill (1981) attest to the above situation when they state:-

> It is claimed, for example, that the Common Entrance Examination, however necessary as an instrument for allocating scarce secondary school places, has had adverse effects because of the inevitable distortions of good primary school education through over-concentration on training for the Common Entrance Tests. This is true. To correct one of the evils, namely, the neglect of certain subjects of the Primary School curriculum, the Ministry of Education and Culture, in collaboration with the Educational Testing Service of Princeton, New Jersey, is working on the inclusion of Social Studies and General Science in the Common Entrance Examination as a means of inducing teachers and pupils to give these subjects the consequence they deserve in the preparation of children of primary school age. If it is known that these subjects are going to be examined, then there is the certainty that they will be taught. (pp. 1-2).

SUMMARY OF CURRICULUM RESEARCH FINDINGS

It is against this background that work on the first elementary science curriculum commenced.

In 1977, the Ministry of Education and the Faculty of Education launched an elementary science curriculum development program. The curriculum were faced with the problem of a complete absence of any basic research in curriculum development. According to Miller (1981):-

> In the Caribbean there has been little inclination to do basic research. A positive research climate and environment is only now beginning to emerge in the Caribbean. Part of the colonial legacy in this region is that there is a readiness to accept opinion as fact, to substitute hunches for conclusions

> from empirical evidence and to make changes without substantial investigation. The colonial experience consisted in rewarding and encouraging imitation rather than innovation. It accepted the thinking that was done elsewhere, the knowledge that was generated in other environments and further accepted that one's responsibility was to adopt and adapt the models and structures developed in the metropolitan countries to the circumstances of the colony. Research was not a part of the responsibility of the colony. The paradigms were worked out elsewhere and force fitted into the local circumstances. In this setting, research had a very low priority. Although a more favourable climate is emerging in the Caribbean, the stage of evolution at the current time could be described as benign interest. Research is recognized as a necessary element and adjunct to development but it is not perceived as being absolutely essential. (pp. 4-5).

No local research on elementary science curriculum development or cognitive development could be found in a review of the literature. Literature review showed that Adey and Manbodh (1977) did a survey of cognitive development in some lower secondary schools and reported that, much of the science curriculum makes demands at the late concrete level, which can only be met by some 35% of first-year pupils.

In an attempt to provide a profile of cognitive development as a prelude to the development, innovation and implementation of the new elementary science curriculum, Fraser-Abder (1977) investigated the cognitive development attainment levels of elementary students in Trinidad and Tobago. Her study showed that at the end of their elementary education at 11 - 12 years old, only 2.8% of the students have attained the late concrete level which Adey and Manbodh (1977) had shown to be required to cope with the secondary level syllabus.

It became apparant that a new science curriculum would have to cater to a very wide range in intellectual development in any given class, and attempt to better prepare students for secondary science.

The results of her study were used to assist in determining the types of activities that can be engaged in by the different age groups. Further research was undertaken to determine content, placement and sequencing of topics in the science curriculum (Fraser-Abder 1982, 1983, 1984). Research in this area continues during the implementation, evaluation and revision stages. Researchers believe that a teacher's attitude toward a subject determines if and how he teaches that subject; it was therefore felt that it was necessary to do some research into the status of the attitude of teachers in Trinidad and Tobago toward science and science teaching.

Fraser-Abder and Shrigley (1980) found that:-

1. Male teachers sampled had a more positive attitude to science and science teaching.
2. Teachers of eleven year olds had a better attitude than teachers of six year old.
3. The type of elementary school attended did not affect the teachers science attitude.
4. Rural and suburban teachers have a significantly higher attitude mean score than urban teachers.
5. Mathematic coursesattended did not affect science attitude and

6. Attitudes scores of teachers having science courses at elementary and secondary levels were significantly higher than teachers having science in elementary schools or those having no science courses.

The teachers sampled showed an overall negative attitude to science teaching. These results were obtained at the commencement of the development of the curriculum. The developers were therefore faced with the task of changing the negative attitude of the teachers in an attempt to better facilitate elementary science teaching.

Fraser-Abder (1984) developed a model which proved to successful in developing a positive attitude to science and science teaching. This model was used with approximately 10% of the teacher population. A new model is currently being used with teachers who have not been directly involved in curriculum development but are now involved in the implementation of the curriculum.

DEVELOPMENT OF SYLLABUS AND CURRICULUM

Traditionally teachers have been presented with science curriculum material and have been expected to teach science. However, this has resulted in disillusionment with the scope and quality of curriculum implementation and developers are beginning to realize the role teachers can play in the process of curriculum development. Teachers are better aware of the classroom situation and if they play an active role in producing classroom material they are more prone to implement the use of this material. Connelly (1972) articulates this belief when he says:

> "The strength and major contribution of a developer are that he works with and can translate involved ideas into a form useful for teachers and students. However, the developer cannot assign, let alone account for the full range of teaching situations that arises. It is here that teachers' experience and wisdom enter into curriculum planning in a way that cannot be adequately be replaced" (P. 79)

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Tyler (1975) accuses curriculum developers of creating non-teachable curricula because they do not know the classroom reality; he feels that teachers should play an active role in curriculum development.

Active teachers participation in curriculum development generally takes two forms:-

1. during implementation, teachers adopt or modify the curricula which were produced by other developers, and they design alternative optional activities if they so desire. (Connelly, 1972; Silberstein, 1978).

2. Teachers act as developers from the initiation of a project. (Rudd, 1975; Gray, 1974, Prestt, 1978.)

In Trinidad and Tobago elementary science curriculum development took the second form, i.e. teachers acted as developers from the initiation of the project.

The current elementary science curriculum, Science - A Process Approach for Trinidad and Tobago, (Douglass and Fraser-Abder, 1979, 1980, 1981, 1982, 1983, 1984) has been developed for Grades 1 through 7 and is now being implemented.

The aims of this curriculum are:-

1. to develop skills in the careful and systematic use to the scientific processes in the elementary school as a necessary preliminary to undertaken more complex science learning in the secondary school.

2. to facilitate the development of the scientific processes which underlie the discovery and continuing development of scientific knowledge.

3. to help children discover, organize and use information to improve living.

4. to facilitate the development of children's thinking.

5. to develop in the child a positive attitude to science. (Fraser-Abder 1979, p. 26).

The major goals of the curriculum development are:

1. the attainment of scientific literacy by all students.

2. the development of a positive attitude towards science and the teaching of science.

3. the improvement of the science background and teaching methods of all teachers.

In the development of the curriculum four major factors had to be considered:-

1. Orientation toward external examinations.

2. Science background and professional training of the teachers.

3. Facilities available at elementary level.

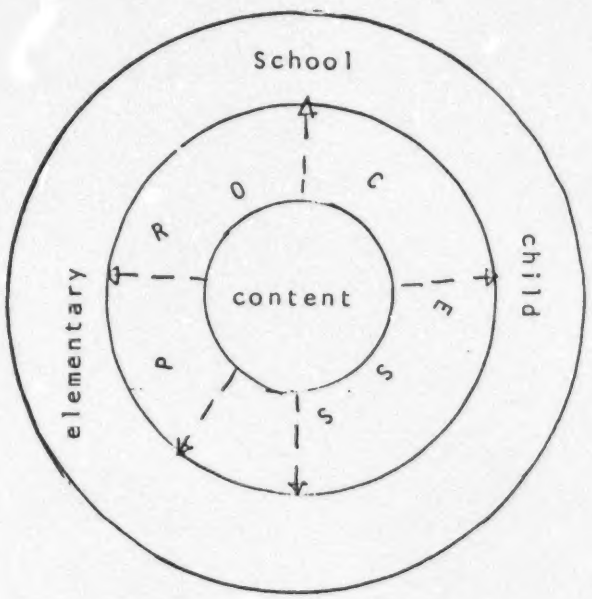
4. Cognitive Developmental level of school population.

SYLLABUS DEVELOPMENT

The content of the syllabus was influenced by the examination done at the end of elementary school, the science educational level of the teachers and attitudinal and cognitive developmental research. The syllabus was developed by Fraser-Abder, Faculty of Education and Douglass, Ministry of Education. The syllabus

comprised philosophy, aims, content, processes and objectives for each elementary school year. Figure 1 shows the relationship between content and process and demonstrates how content is assimilated via the use of the processes.

FIGURE 1 - PROCESS/CONTENT RELATIONSHIP



CURRICULUM DEVELOPMENT

Teachers were involved in the development of the curriculum during the peiod 1977 - 1983. They attended workshops the major objectives of which were :-

1. To change the teacher's negative attitude to science teaching.
2. To expose teachers to teaching science using the process approach of science teaching.
3. To involve teachers in developing and writing activities to be done in the schools.
4. To expose teachers to teaching strategies involving hands-on experiences.

Five basic elements were interwoven into the workshops:-

1. Introduction to the principles of curriculum development.

2. Designing activities aimed at increasing teachers' knowledge of science and science teaching.

3. Deliberations on approaches to science curriculum development.

4. Development and production of learning materials for use by all elementary students.

5. Interaction with fellow teachers, trying out the materials and revising and modifying them based on feedback collected via trials in schools.

During workshops teachers developed activities for use by students. These activities were tested and evaluated in the schools and revised based on this initial evaluation.

The activities which resulted from the work of these teachers were edited and revised by the curriculum developers and published in the form of a Teacher's Guide and distributed for use in all elementary schools.

Seven hundred (700) teachers (approximately 10% of the elementary teachers population) were directly involved in writing curriculum activities. These teachers later served as resource persons in their schools and assisted in the implementation of the curriculum.

PLAN OF RESEARCH

This research focuses specifically on the implementation and evaluation of the SAPATT Curriculum.

STATEMENT OF PROBLEMS

This study attempts to investigate

A. Attitude

1. The attitude of principals, teachers, students and parents to SAPATT and Science Teaching.

B. Implementation

1. The most effective method of implementing the curriculum;
2. The principal characteristics of the methodology used in the teaching of elementary science.
3. The administrative conditions that directly influence the teaching of science.
4. The major setback to implementation.
5. The type of supervision that is necessary to ensure effective implementation.
6. The effect of school cluster workshops on implementation.

C. Evaluation

1. Student performance in the Common Entrance 1982-1985.
2. The measurement of evaluation system utilized by elementary teachers in the Science Program.
3. The pre-test and post-test performance of students on individual lessons.
4. A survey of equipment availability, supply and storage.

METHODOLOGY

A. Attitude

Attitude scales will be administered to a random sample of supervisors, Teachers College Lecturers, Principals, Teachers, Students and Parents.

Category	Sample Size
Supervisors	5
T.C. Lecturers	6
Principals	50
Teachers	500
Students	2000
Parents	100

B. Implementation

(a) This will involve workshops held in school clusters. Each workshop to include 50-60% of the teachers in the participating schools.

The objectives of these workshops are:-

1. to increase the teachers knowledge of science and science teaching.
2. to expose teachers to teaching science using the process approach.
3. to change the teachers negative attitude to science teaching.

A questionnaire will be administered to each participating teacher. An Attitude scale will be given as a pre-test and post-test at each workshop. The effect of the workshops on teachers attitude will then be analysed.

(b) Workshops held at county level for specific class level teachers.

C. Evaluation

This will include:-

a. Review of Teacher's Guides by professional Curriculum Development.

b. Survey of student performance on the Common Entrance Examination (1982-1985).

c. Pre-test and post-test results of students performance on individual competency measure tasks. The treatment will be the SAPATT lesson.

d. Comparison of performance of students who have used the SAPATT Curriculum and those who have not on a test geared to test student achievement of the processes.

e. A survey of the measurement and evaluation system utilized by elementary teachers in the Science Program.

f. A survey of equipment availability, supply and storage.

g. Classroom visitation and evaluation of lessons by curriculum developers.

h. Teachers evaluation of the SAPATT Curriculum.

i. Student evaluation of the SAPATT Curriculum.

PURPOSE OF PRESENT PHASE OF STUDY

This phase of the study attempts to do a preliminary summative evaluation of the curriculum, using students who have done the program over a period of six years and students who have not been exposed to the program and teachers who have been actively involved in developing and implementing the curriculum. Specifically the study attempts to test the following null hypotheses.

(1) Students who have followed the program for six years will not perform significantly better than students who have not followed the program when given a test to measure their attainment of the process skills.

(2) Teachers will not rate the curriculum as successful in terms of the following criteria:-

(i) Student interest

(ii) Student active participation

(iii) Student attainment of the process skills

(iv) Usefulness of the Teachers Guide

(v) Teachers enjoyment in teaching lesson

(vii) Necessity for further reading material/workbook

(viii) Necessity for further training in science.

PROCEDURE

The study involved the use of two instruments:

(1) A 25-item test made up of Process questions based on the SAPATT Curriculum.

(2) A 24-item opinionnaire for teachers who were actively involved in teaching the curriculum.

The 25-item test was given to 288 SAPATT students in public schools. This was designated the experimental group. These schools had been actively involved in developing and implementing the curriculum. The control group comprised 258 (non-SAPATT) students in private schools. These schools were not using the curriculum and taught some science using a content, rote memorization approach. Teachers at these schools were not involved in the curriculum development project.

The 24 item five-point Likert type opinionnaire was given to 17 teachers who were actively involved in developing and implementing the program. The opinionnaire contained statements on each of the eight criteria mentioned in hypothesis 2. A response of 1-3 was indicative of a low rating while a mean response of 3-5 signified a high rating.

TABLE I

RESULTS AND CONCLUSIONS

Comparison of scores of Experimental and Control Groups.

	N	Mean	S.D.	t-test	F-ratio	X^2
Experimental	288	16.57	4.33	37.99 xxx	362.3 xxx	280.49 xxx
Control	258	10.11	3.59			

ANALYSIS OF TEACHERS RESPONSES TO OPINIONNAIRE

CRITERIA		Mean Response	Rating
I	Student Interest	4.20	high
II	Student active participation	4.09	high
III	Student attainment of the process Skills	4.01	high
IV	Usefulness of the Teachers Guide	4.38	high
V	Teachers enjoyment in teaching Lesson	4.81	high
VI	Availability of material	2.47	low
VII	Necessity for further reading material/workbook	2.98	low
VIII	Necessity for further training in science	2.14	low

Hypothesis 1: This was rejected at the .001 level of significance. There is a significant difference between SAPATT and non-SAPATT students.

Hypothesis 2: The teacher opinionnaire showed that teachers rated student interest, active involvement and achievement of process skills as high. Teachers Guides were thought to be highly useful and well developed. There was need for supplemental reading material and student workbooks. The areas of greatest needs were the supply of material to school and further training for all teachers in the school system.

IMPLICATIONS FOR TEACHING SCIENCE

Since the Common Entrance examination, a pass in which entitles the student to free secondary education is based on the SAPATTCurriculum and in view of the high scores achieved by SAPATT students and the teachers high opinion of interest, active participation and attainment of the process skills by students who have been exposed to the SAPATT curriculum, all schools private and public should use the program.

The Teachers Guides which teachers judged to be highly useful should be distributed to all schools. Some attempt should be made to make science equipment and reading material more accessible to all schools, students workbooks should be produced. There is also a greatly perceived need to continue training teachers in science.

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